Then the tube is filled with different concentrations of the contrast agents. Full rinsing is conducted between each injection of different contrast media. A needle hydrophone (Precison Acoustics Ltd.) is utilized to record the acoustic wave at 45°, 90°, 135° and 180° relative to the circumference of cellulose tubing.

Blood Flow Imaging

The dynamic blood flow imaging characteristics of different concentrations of unmodified and surface-modified GOAM are examined using sterile water, plasma, and whole blood. Two different flow systems are used. The first consists of a tissue mimicking flow phantom (ATS Laboratories, Bridgeport, CT) with a 6 mm diameter flow channel for simulating large vessels. The second system utilizes the tank and cellulose tubing apparatus described above which simulate smaller capillaries. (This system lacks a tissue mimicking interface.) A precision flow pump provides both constant and pulsatile flows. These imaging data are recorded directly on to the hard disk of a PC using the color video output of the Aloka 5500 PHD connected to the image acquisition system described above. The effects of different concentrations on the spectral Doppler signals from the Aloka 5500 are examined along with the effects on both color Doppler and "Power Flow" imaging in B-mode.

Example 5 - MR Characterization

T_1 and T_2 relaxation are determined for unmodified and surface-modified GOAM, GOAM made from pegylated Gd_2O_3 colloid solution, Gd_2O_3 colloid solution and GOAM having encapsulated pegylated Gd_2O_3 at various concentrations using different pH and temperatures. Imaging of the above reagents is conducted in sterile water, plasma, and whole blood in order to better approximate physiological conditions.

Images are obtained on a 3.0T imaging spectrometer with image processing and display system. A partial saturation pulsing sequence is utilized for T_1 weighted 2D acquisitions. T_1 values are derived by an inversion recovery method and curve fitted by the least squares techniques (i.e. Niesman et al., "Liposome Encapsulated MgCl as Liver Specific Contrast Agent for Magnetic Resonance Imaging," *Investigative Radiology*, 25:545-51 (1990) which is incorporated by reference herein). T_2 values are derived by the Carr-Purcell-Meiboom-Gill pulse sequence with curve fitting by the least squares method.

Additional studies involve measurement of T_1 and T_2 relaxation at different magnetic field strengths using a 3T spectrometer.

Example 6 – Simulation of Ultrasound Wave Propagation

Ultrasound wave propagation in a synthetically generated medium was simulated. The simulation consisted of a bubble with an outer diameter of 250 μm and inner diameter of 225 μm. The bubble was surrounded by an albumin shell of thickness 12.5 μm. Figures 5a-5d illustrate a sequence of snapshots of the absolute value of the scattered wave. The simulation shows the progress of an ultrasound wave toward a single spherical target. Figures 5a-5d illustrate that the ultrasonic wave hitting the sphere, as well as the wave being reflected (the backscattered wave), is accurately simulated.

Example 7 – CT Characterization

CT attenuation of unmodified and surface-modified GOAM, GOAM made from pegylated Gd_2O_3 colloid solution, Gd_2O_3 colloid solution and GOAM having encapsulated pegylated Gd_2O_3 at various concentrations, as well as the lowest dose providing acceptable enhancement are determined. Serial dilutions of the above reagents in normal saline or

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distilled water are placed in a tissue equivalent phantom and positioned in the center of the gantry of the CT scanner. The phantom containing the above reagents is imaged under the following constant scanning parameters: slice thickness of 10 mm, 120 keV, 250 mA, scan time of 1 second and a 25 cm field of view. Attenuation measurements obtained from region of interest circles of approximately 80 mm3 (10 mm thickness) are plotted against the concentrations of the reagents, and a linear regression analysis is performed. The attenuation of each dilution is recorded as mean Hounsfield units using region of interest analysis.

Example 8 – RF Data Acquisition

Figure 6 illustrates RF acquisition data for B-mode ultrasound imaging comparing GOAM of the present invention, air-filled albumin microspheres, and free Gd_2O_3. The photographs in the left column show an ultrasound image of a cross-sectional view of a 1.5 ml eppendorf tube on its side and having either GOAM, albumin microspheres or free Gd_2O_3 contained within. The GOAM solution has a bubble concentration of 10^6 bubbles/ml and a Gd_2O_3 concentration of 0.02 mmol. The albumin microspheres solution has a bubble concentration of 10^6 bubbles/ml. The free Gd_2O_3 has a concentration of 200 mmol. To the right of each image is a plot of RF data illustrating amplitude over time as the ultrasound wave passed through the eppendorf tube from the top, through the contrast agent and then through the bottom. This test demonstrates that GOAM provides much greater RF attenuation than the other contrast agents.

Example 9 – Ultrasonic Attenuation

As shown in Figure 7, ultrasonic attenuation of GOAM of the present invention is compared to that of air-filled albumin microspheres, and free Gd_2O_3. Ultrasonic attenuation